This key should allow you to understand why you choose the option you did (beyond just getting a question right or wrong). More instructions on how to use this key can be found here.

If you have a suggestion to make the keys better, please fill out the short survey here.

Note: This key is auto-generated and may contain issues and/or errors. The keys are reviewed after each exam to ensure grading is done accurately. If there are issues (like duplicate options), they are noted in the offline gradebook. The keys are a work-in-progress to give students as many resources to improve as possible.

---

1. Construct the lowest-degree polynomial given the zeros below. Then, choose the intervals that contain the coefficients of the polynomial in the form $ax^3 + bx^2 + cx + d$.

$$\frac{-4}{5}, \frac{-1}{2}, \text{ and } \frac{2}{5}$$

The solution is $50x^3 + 45x^2 - 6x - 8$, which is option D.

A. $a \in [47, 51], b \in [44, 46], c \in [-10, -4],$ and $d \in [5, 10]$

$50x^3 + 45x^2 - 6x + 8$, which corresponds to multiplying everything correctly except the constant term.

B. $a \in [47, 51], b \in [-86, -79], c \in [41, 48],$ and $d \in [-11, -2]$

$50x^3 - 85x^2 + 46x - 8$, which corresponds to multiplying out $(5x - 4)(2x - 1)(5x - 2)$.

C. $a \in [47, 51], b \in [-50, -44], c \in [-10, -4],$ and $d \in [5, 10]$

$50x^3 - 45x^2 - 6x + 8$, which corresponds to multiplying out $(5x - 4)(2x - 1)(5x + 2)$.

D. $a \in [47, 51], b \in [44, 46], c \in [-10, -4],$ and $d \in [-11, -2]$

* $50x^3 + 45x^2 - 6x - 8$, which is the correct option.

E. $a \in [47, 51], b \in [-35, -28], c \in [-16, -10],$ and $d \in [5, 10]$

$50x^3 - 35x^2 - 14x + 8$, which corresponds to multiplying out $(5x - 4)(2x + 1)(5x - 2)$.

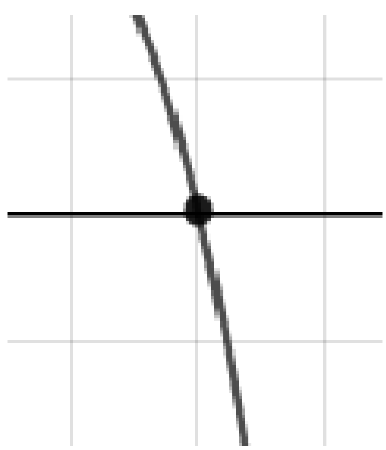
General Comment: To construct the lowest-degree polynomial, you want to multiply out $(5x + 4)(2x + 1)(5x - 2)$

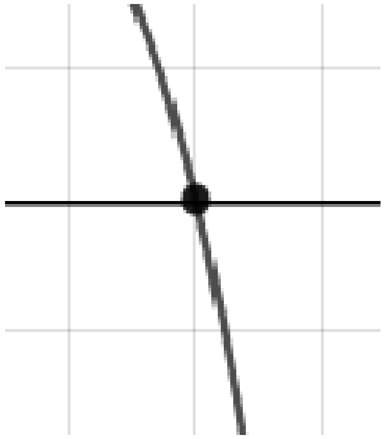
---

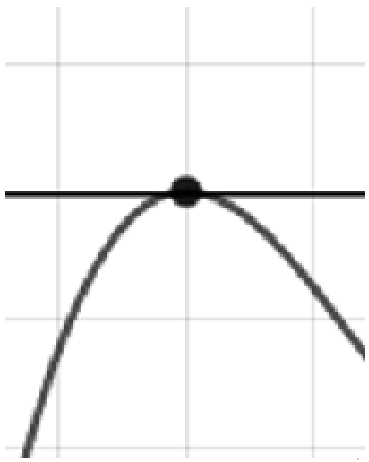
2. Describe the zero behavior of the zero $x = 4$ of the polynomial below.

$$f(x) = -5(x + 4)^6(x - 4)^7(x + 5)^3(x - 5)^6$$

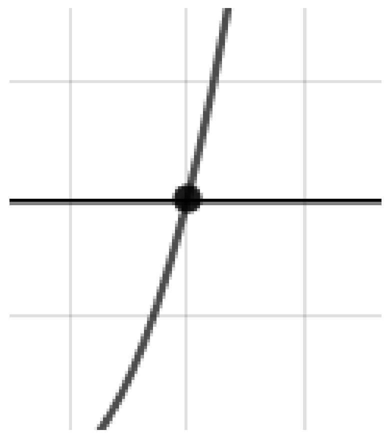
The solution is the graph below, which is option A.



A. 

B. 

C. 

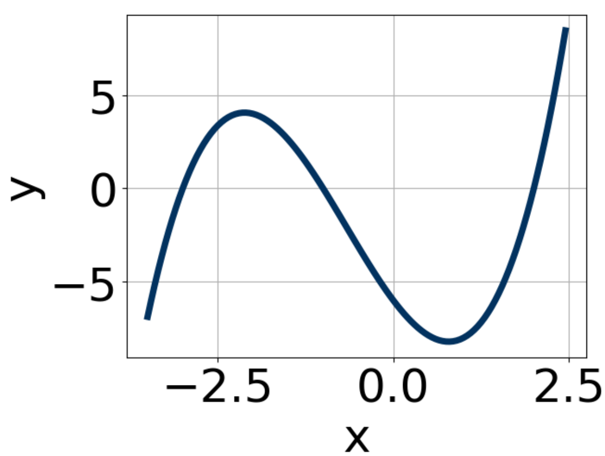
D. 

E. None of the above.

General Comment: You will need to sketch the entire graph, then zoom in on the zero the question asks about.

---

3. Which of the following equations *could* be of the graph presented below?



The solution is $15(x-2)^7(x+1)^5(x+3)^7$, which is option C.

A. $17(x-2)^8(x+1)^9(x+3)^{11}$

The factor 2 should have been an odd power.

B. $-7(x-2)^4(x+1)^7(x+3)^{11}$

The factor $(x-2)$ should have an odd power and the leading coefficient should be the opposite sign.

C. $15(x-2)^7(x+1)^5(x+3)^7$

* This is the correct option.

D. $-2(x-2)^{11}(x+1)^9(x+3)^9$

This corresponds to the leading coefficient being the opposite value than it should be.

E. $7(x-2)^{10}(x+1)^8(x+3)^{11}$

The factors 2 and -1 have have been odd power.

General Comment: General Comments: Draw the x-axis to determine which zeros are touching (and so have even multiplicity) or cross (and have odd multiplicity).

---

4. Construct the lowest-degree polynomial given the zeros below. Then, choose the intervals that contain the coefficients of the polynomial in the form $x^3 + bx^2 + cx + d$.

$$-4 - 2i \text{ and } -1$$

The solution is $x^3 + 9x^2 + 28x + 20$, which is option B.

A. $b \in [0, 4], c \in [4.37, 5.42], \text{ and } d \in [2.7, 4.8]$

$x^3 + x^2 + 5x + 4$, which corresponds to multiplying out $(x+4)(x+1)$.

B. $b \in [6, 11], c \in [27.08, 28.41], \text{ and } d \in [14.4, 20.2]$

* $x^3 + 9x^2 + 28x + 20$, which is the correct option.

C. $b \in [-9, -7], c \in [27.08, 28.41], \text{ and } d \in [-20.3, -18.9]$

$x^3 - 9x^2 + 28x - 20$, which corresponds to multiplying out $(x-(-4-2i))(x-(-4+2i))(x-1)$.

D. $b \in [0, 4], c \in [0.79, 4.62], \text{ and } d \in [-0.4, 3.2]$

$x^3 + x^2 + 3x + 2$, which corresponds to multiplying out $(x+2)(x+1)$.

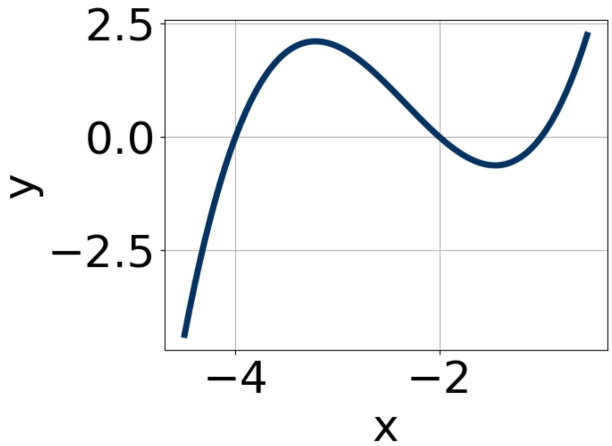
E. None of the above.

This corresponds to making an unanticipated error or not understanding how to use nonreal complex numbers to create the lowest-degree polynomial. If you chose this and are not sure what you did wrong, please contact the coordinator for help.

General Comment: Remember that the conjugate of $a+bi$ is $a-bi$. Since these zeros always come in pairs, we need to multiply out $(x-(-4-2i))(x-(-4+2i))(x-(-1))$.

---

5. Which of the following equations *could* be of the graph presented below?



The solution is $9(x+1)^9(x+2)^7(x+4)^{11}$, which is option C.

A. $-7(x+1)^5(x+2)^9(x+4)^9$

This corresponds to the leading coefficient being the opposite value than it should be.

B. $10(x+1)^{10}(x+2)^5(x+4)^7$

The factor -1 should have been an odd power.

C. $9(x+1)^9(x+2)^7(x+4)^{11}$

* This is the correct option.

D. $-2(x+1)^{10}(x+2)^5(x+4)^5$

The factor $(x+1)$ should have an odd power and the leading coefficient should be the opposite sign.

E. $20(x+1)^{10}(x+2)^8(x+4)^9$

The factors -1 and -2 have have been odd power.

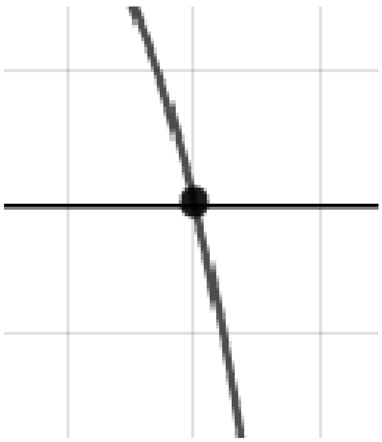
General Comment: General Comments: Draw the x-axis to determine which zeros are touching (and so have even multiplicity) or cross (and have odd multiplicity).

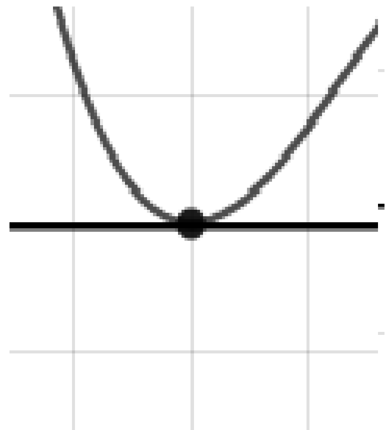
---

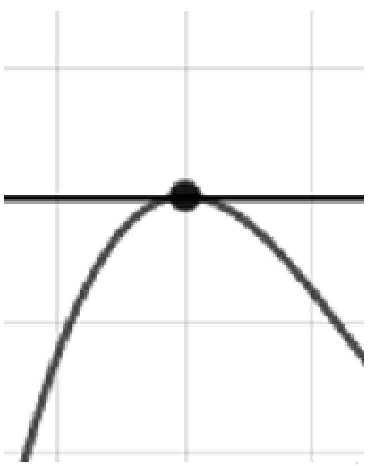
6. Describe the zero behavior of the zero $x = 3$ of the polynomial below.

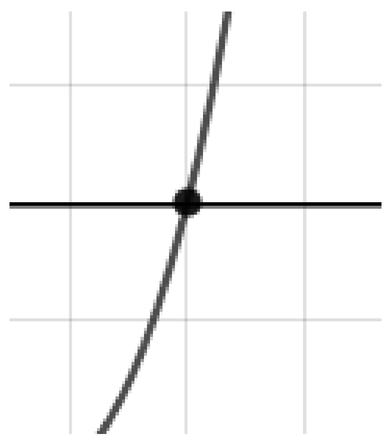
$$f(x) = 6(x+5)^4(x-5)^2(x+3)^{13}(x-3)^8$$

The solution is the graph below, which is option C.

A. 

C. 

B. 

D. 

E. None of the above.

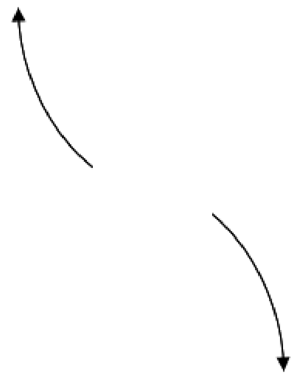
General Comment: You will need to sketch the entire graph, then zoom in on the zero the question asks about.

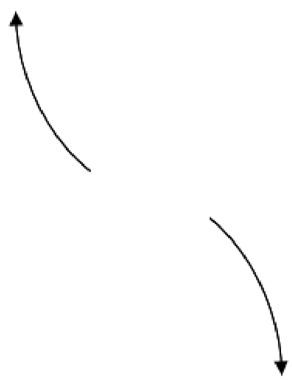
---

7. Describe the end behavior of the polynomial below.

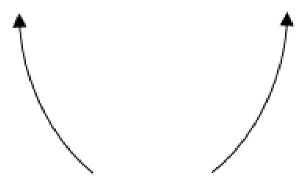
$$f(x) = -9(x-5)^3(x+5)^8(x-6)^4(x+6)^6$$

The solution is the graph below, which is option A.

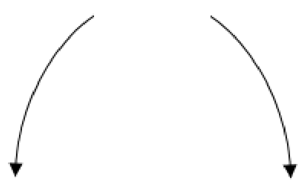




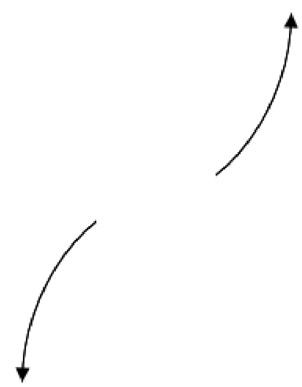
A.



C.



B.



D.

E. None of the above.

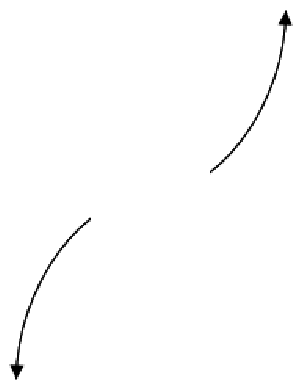
General Comment: Remember that end behavior is determined by the leading coefficient AND whether the **sum** of the multiplicities is positive or negative.

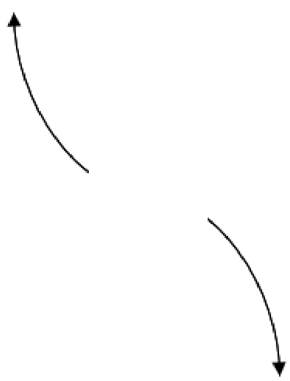
---

8. Describe the end behavior of the polynomial below.

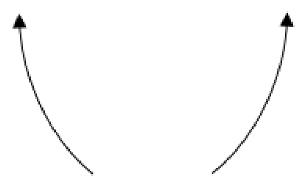
$$f(x) = 2(x+2)^2(x-2)^7(x+8)^4(x-8)^4$$

The solution is the graph below, which is option D.

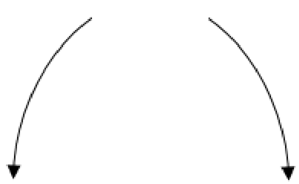




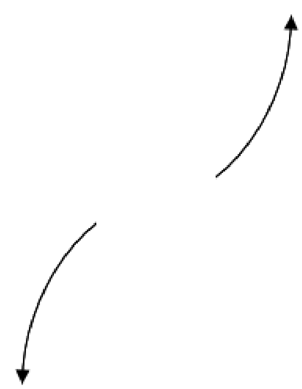
A.



C.



B.



D.

E. None of the above.

General Comment: Remember that end behavior is determined by the leading coefficient AND whether the **sum** of the multiplicities is positive or negative.

---

9. Construct the lowest-degree polynomial given the zeros below. Then, choose the intervals that contain the coefficients of the polynomial in the form $ax^3 + bx^2 + cx + d$.

$$\frac{4}{3}, \frac{7}{5}, \text{ and } \frac{-1}{3}$$

The solution is $45x^3 - 108x^2 + 43x + 28$, which is option D.

A. $a \in [44, 48], b \in [-108, -105], c \in [40, 50], \text{ and } d \in [-28, -27]$

$45x^3 - 108x^2 + 43x - 28$, which corresponds to multiplying everything correctly except the constant term.

B. $a \in [44, 48], b \in [9, 14], c \in [-86, -82]$, and $d \in [-28, -27]$

$45x^3 + 12x^2 - 85x - 28$, which corresponds to multiplying out $(3x + 4)(5x - 7)(3x + 1)$.

C. $a \in [44, 48], b \in [127, 141], c \in [121, 128]$, and $d \in [25, 34]$

$45x^3 + 138x^2 + 125x + 28$, which corresponds to multiplying out $(3x + 4)(5x + 7)(3x + 1)$.

D. $a \in [44, 48], b \in [-108, -105], c \in [40, 50]$, and $d \in [25, 34]$

* $45x^3 - 108x^2 + 43x + 28$, which is the correct option.

E. $a \in [44, 48], b \in [107, 110], c \in [40, 50]$, and $d \in [-28, -27]$

$45x^3 + 108x^2 + 43x - 28$, which corresponds to multiplying out $(3x + 4)(5x + 7)(3x - 1)$.

General Comment: To construct the lowest-degree polynomial, you want to multiply out $(3x - 4)(5x - 7)(3x + 1)$

---

10. Construct the lowest-degree polynomial given the zeros below. Then, choose the intervals that contain the coefficients of the polynomial in the form $x^3 + bx^2 + cx + d$.

$$-5 - 3i \text{ and } 1$$

The solution is $x^3 + 9x^2 + 24x - 34$, which is option A.

A. $b \in [4, 14], c \in [23.5, 25.2]$, and $d \in [-34.6, -33]$

* $x^3 + 9x^2 + 24x - 34$, which is the correct option.

B. $b \in [-5, 6], c \in [3.8, 6.7]$, and $d \in [-6.8, -4]$

$x^3 + x^2 + 4x - 5$, which corresponds to multiplying out $(x + 5)(x - 1)$.

C. $b \in [-10, -2], c \in [23.5, 25.2]$, and $d \in [33.9, 36.6]$

$x^3 - 9x^2 + 24x + 34$, which corresponds to multiplying out $(x - (-5 - 3i))(x - (-5 + 3i))(x + 1)$.

D. $b \in [-5, 6], c \in [-1.7, 3.3]$, and $d \in [-3.6, -0.7]$

$x^3 + x^2 + 2x - 3$, which corresponds to multiplying out $(x + 3)(x - 1)$.

E. None of the above.

This corresponds to making an unanticipated error or not understanding how to use nonreal complex numbers to create the lowest-degree polynomial. If you chose this and are not sure what you did wrong, please contact the coordinator for help.

General Comment: Remember that the conjugate of $a + bi$ is $a - bi$. Since these zeros always come in pairs, we need to multiply out $(x - (-5 - 3i))(x - (-5 + 3i))(x - (1))$.

---

11. Construct the lowest-degree polynomial given the zeros below. Then, choose the intervals that contain the coefficients of the polynomial in the form $ax^3 + bx^2 + cx + d$.

$$\frac{5}{3}, \frac{-1}{4}, \text{ and } \frac{-5}{2}$$

The solution is $24x^3 + 26x^2 - 95x - 25$, which is option D.

A. $a \in [23, 25], b \in [-28, -20], c \in [-98, -94]$, and $d \in [21, 27]$

$24x^3 - 26x^2 - 95x + 25$, which corresponds to multiplying out $(3x + 5)(4x - 1)(2x - 5)$.

B. $a \in [23, 25], b \in [106, 107], c \in [123, 131]$, and $d \in [21, 27]$

$24x^3 + 106x^2 + 125x + 25$, which corresponds to multiplying out $(3x + 5)(4x + 1)(2x + 5)$.

C. $a \in [23, 25], b \in [26, 29], c \in [-98, -94]$, and $d \in [21, 27]$

$24x^3 + 26x^2 - 95x + 25$, which corresponds to multiplying everything correctly except the constant term.

D. $a \in [23, 25], b \in [26, 29], c \in [-98, -94]$, and $d \in [-26, -21]$

* $24x^3 + 26x^2 - 95x - 25$, which is the correct option.

E. $a \in [23, 25], b \in [90, 99], c \in [74, 78]$, and $d \in [-26, -21]$

$24x^3 + 94x^2 + 75x - 25$, which corresponds to multiplying out $(3x + 5)(4x - 1)(2x + 5)$.

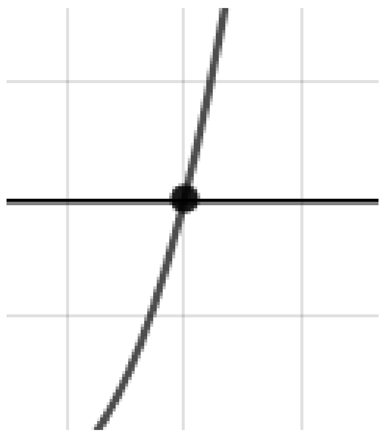
General Comment: To construct the lowest-degree polynomial, you want to multiply out $(3x - 5)(4x + 1)(2x + 5)$

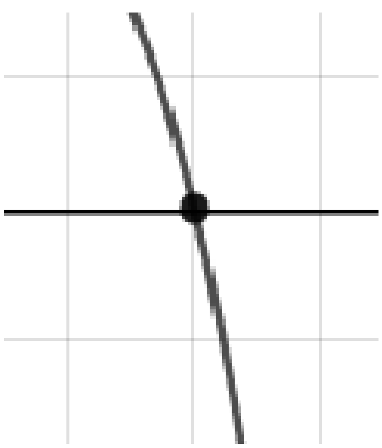
---

12. Describe the zero behavior of the zero $x = -3$ of the polynomial below.

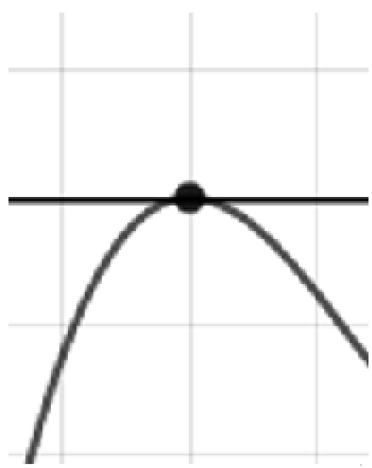
$$f(x) = -2(x - 3)^4(x + 3)^7(x + 2)^7(x - 2)^{10}$$

The solution is the graph below, which is option D.



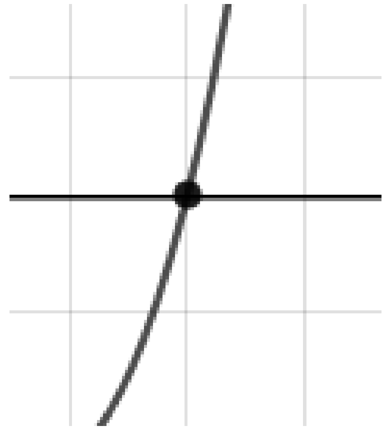


A.



B.

C. 

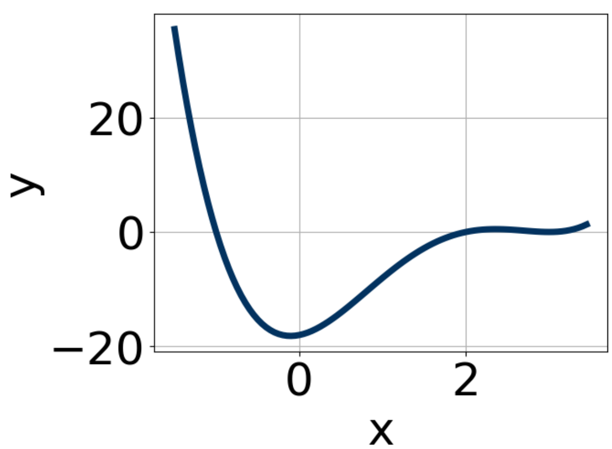
D. 

E. None of the above.

General Comment: You will need to sketch the entire graph, then zoom in on the zero the question asks about.

---

13. Which of the following equations *could* be of the graph presented below?



The solution is $5(x-3)^{10}(x-2)^{11}(x+1)^{11}$, which is option B.

A. $18(x-3)^4(x-2)^{10}(x+1)^{11}$

The factor $(x-2)$ should have an odd power.

B. $5(x-3)^{10}(x-2)^{11}(x+1)^{11}$

* This is the correct option.

C. $-14(x-3)^{10}(x-2)^{11}(x+1)^4$

The factor $(x+1)$ should have an odd power and the leading coefficient should be the opposite sign.

D. $18(x-3)^7(x-2)^4(x+1)^7$

The factor 3 should have an even power and the factor 2 should have an odd power.

E. $-10(x-3)^4(x-2)^9(x+1)^{11}$

This corresponds to the leading coefficient being the opposite value than it should be.

General Comment: General Comments: Draw the x-axis to determine which zeros are touching (and so have even multiplicity) or cross (and have odd multiplicity).

---

14. Construct the lowest-degree polynomial given the zeros below. Then, choose the intervals that contain the coefficients of the polynomial in the form $x^3 + bx^2 + cx + d$.

$$-3 - 4i \text{ and } -3$$

The solution is $x^3 + 9x^2 + 43x + 75$, which is option C.

A. $b \in [-3, 3], c \in [6.2, 9.3],$ and $d \in [12, 14]$

$x^3 + x^2 + 7x + 12$, which corresponds to multiplying out $(x + 4)(x + 3)$.

B. $b \in [-12, -8], c \in [42, 47.2],$ and $d \in [-75, -74]$

$x^3 - 9x^2 + 43x - 75$, which corresponds to multiplying out $(x - (-3 - 4i))(x - (-3 + 4i))(x - 3)$.

C. $b \in [9, 13], c \in [42, 47.2],$ and $d \in [72, 82]$

* $x^3 + 9x^2 + 43x + 75$, which is the correct option.

D. $b \in [-3, 3], c \in [2.5, 6.7],$ and $d \in [5, 11]$

$x^3 + x^2 + 6x + 9$, which corresponds to multiplying out $(x + 3)(x + 3)$.

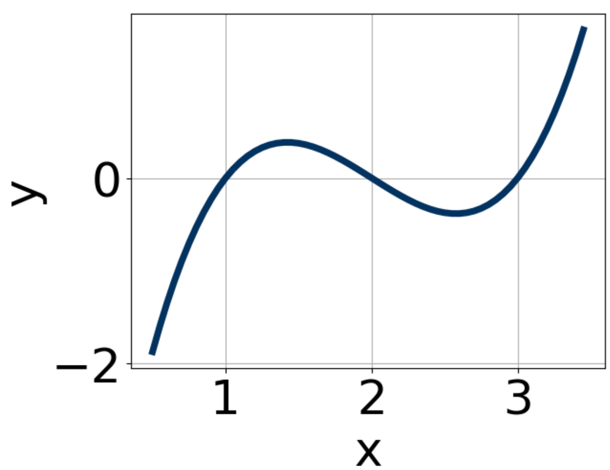
E. None of the above.

This corresponds to making an unanticipated error or not understanding how to use nonreal complex numbers to create the lowest-degree polynomial. If you chose this and are not sure what you did wrong, please contact the coordinator for help.

General Comment: Remember that the conjugate of $a + bi$ is $a - bi$. Since these zeros always come in pairs, we need to multiply out $(x - (-3 - 4i))(x - (-3 + 4i))(x - (-3))$.

---

15. Which of the following equations *could* be of the graph presented below?



The solution is $4(x - 1)^7(x - 2)^5(x - 3)^9$, which is option D.

A. $-20(x - 1)^8(x - 2)^9(x - 3)^5$

The factor $(x - 1)$ should have an odd power and the leading coefficient should be the opposite sign.

B. $20(x-1)^8(x-2)^5(x-3)^7$

The factor 1 should have been an odd power.

C. $-5(x-1)^{11}(x-2)^{11}(x-3)^5$

This corresponds to the leading coefficient being the opposite value than it should be.

D. $4(x-1)^7(x-2)^5(x-3)^9$

* This is the correct option.

E. $7(x-1)^8(x-2)^6(x-3)^7$

The factors 1 and 2 have have been odd power.

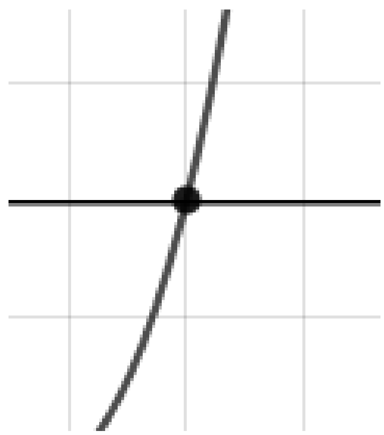
General Comment: General Comments: Draw the x-axis to determine which zeros are touching (and so have even multiplicity) or cross (and have odd multiplicity).

---

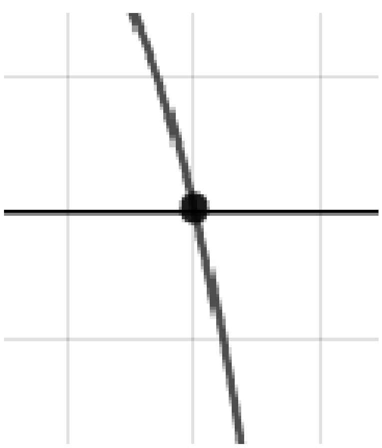
16. Describe the zero behavior of the zero $x = 5$ of the polynomial below.

$$f(x) = 4(x-2)^6(x+2)^3(x-5)^7(x+5)^2$$

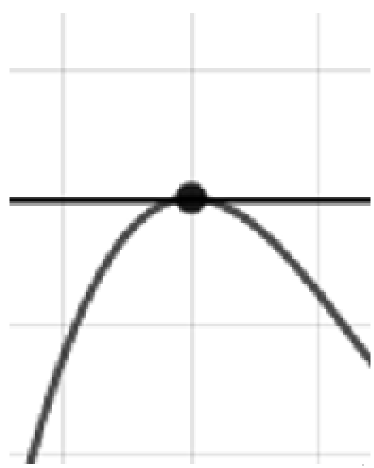
The solution is the graph below, which is option D.



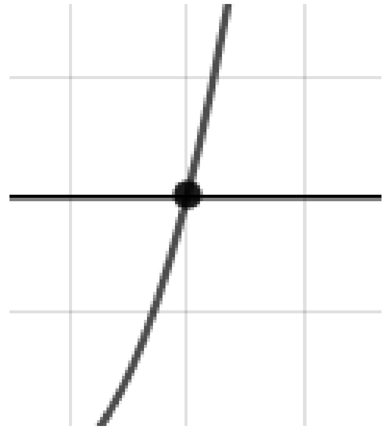
A.



B.



C. 

D. 

E. None of the above.

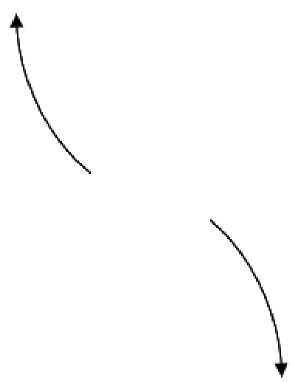
General Comment: You will need to sketch the entire graph, then zoom in on the zero the question asks about.

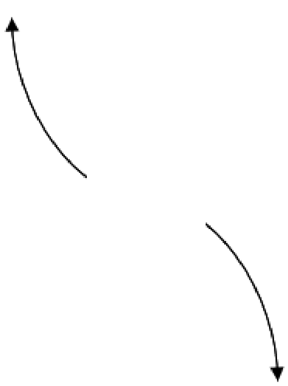
---

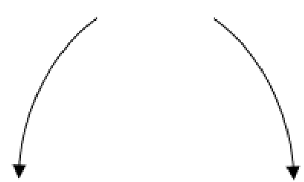
17. Describe the end behavior of the polynomial below.

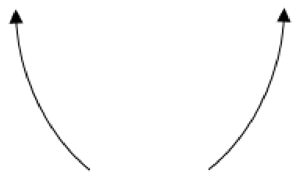
$$f(x) = -2(x+2)^3(x-2)^8(x-9)^4(x+9)^6$$

The solution is the graph below, which is option A.

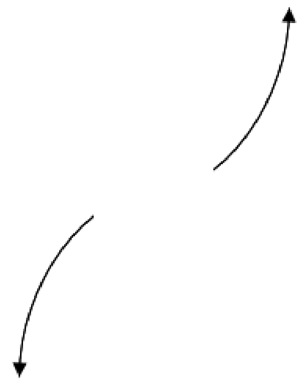


A. 

B. 



C.



D.

E. None of the above.

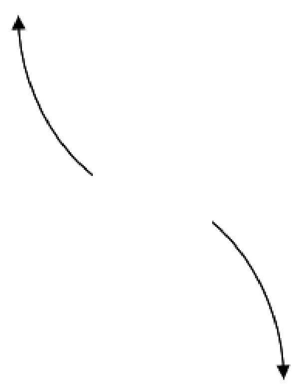
General Comment: Remember that end behavior is determined by the leading coefficient AND whether the **sum** of the multiplicities is positive or negative.

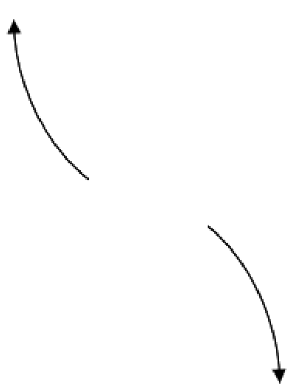
---

18. Describe the end behavior of the polynomial below.

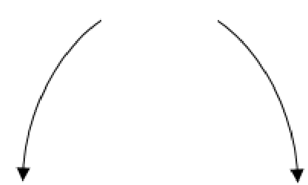
$$f(x) = -4(x-5)^5(x+5)^8(x-4)^5(x+4)^5$$

The solution is the graph below, which is option A.

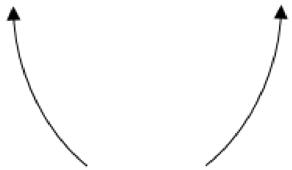


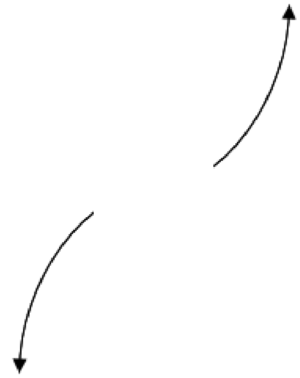


A.



B.

C. 

D. 

E. None of the above.

General Comment: Remember that end behavior is determined by the leading coefficient AND whether the **sum** of the multiplicities is positive or negative.

---

19. Construct the lowest-degree polynomial given the zeros below. Then, choose the intervals that contain the coefficients of the polynomial in the form $ax^3 + bx^2 + cx + d$.

$$\frac{4}{3}, \frac{1}{4}, \text{ and } 1$$

The solution is $12x^3 - 31x^2 + 23x - 4$, which is option D.

A. $a \in [11, 21], b \in [-0.6, 2.1], c \in [-19.5, -16.4], \text{ and } d \in [2, 6]$

$12x^3 + x^2 - 17x + 4$, which corresponds to multiplying out $(3x + 4)(4x - 1)(x - 1)$.

B. $a \in [11, 21], b \in [1.5, 8.2], c \in [-16, -14.6], \text{ and } d \in [-6, 0]$

$12x^3 + 7x^2 - 15x - 4$, which corresponds to multiplying out $(3x + 4)(4x + 1)(x - 1)$.

C. $a \in [11, 21], b \in [30.9, 32.5], c \in [20.5, 27.3], \text{ and } d \in [2, 6]$

$12x^3 + 31x^2 + 23x + 4$, which corresponds to multiplying out $(3x + 4)(4x + 1)(x + 1)$.

D. $a \in [11, 21], b \in [-32.9, -28.5], c \in [20.5, 27.3], \text{ and } d \in [-6, 0]$

* $12x^3 - 31x^2 + 23x - 4$, which is the correct option.

E. $a \in [11, 21], b \in [-32.9, -28.5], c \in [20.5, 27.3], \text{ and } d \in [2, 6]$

$12x^3 - 31x^2 + 23x + 4$, which corresponds to multiplying everything correctly except the constant term.

General Comment: To construct the lowest-degree polynomial, you want to multiply out $(3x - 4)(4x - 1)(x - 1)$

---

20. Construct the lowest-degree polynomial given the zeros below. Then, choose the intervals that contain the coefficients of the polynomial in the form $x^3 + bx^2 + cx + d$.

$$-2 + 3i \text{ and } -1$$

The solution is $x^3 + 5x^2 + 17x + 13$, which is option D.

A. $b \in [0.1, 3.9], c \in [-7, 0],$ and $d \in [-5.5, -1.1]$

$x^3 + x^2 - 2x - 3$, which corresponds to multiplying out $(x - 3)(x + 1)$.

B. $b \in [-10.8, -3], c \in [12, 26],$ and $d \in [-14.5, -9.4]$

$x^3 - 5x^2 + 17x - 13$, which corresponds to multiplying out $(x - (-2 + 3i))(x - (-2 - 3i))(x - 1)$.

C. $b \in [0.1, 3.9], c \in [2, 8],$ and $d \in [0.4, 3.8]$

$x^3 + x^2 + 3x + 2$, which corresponds to multiplying out $(x + 2)(x + 1)$.

D. $b \in [2.5, 6.7], c \in [12, 26],$ and $d \in [12.3, 16.1]$

* $x^3 + 5x^2 + 17x + 13$, which is the correct option.

E. None of the above.

This corresponds to making an unanticipated error or not understanding how to use nonreal complex numbers to create the lowest-degree polynomial. If you chose this and are not sure what you did wrong, please contact the coordinator for help.

General Comment: Remember that the conjugate of $a + bi$ is $a - bi$. Since these zeros always come in pairs, we need to multiply out $(x - (-2 + 3i))(x - (-2 - 3i))(x - (-1))$.

---

21. Construct the lowest-degree polynomial given the zeros below. Then, choose the intervals that contain the coefficients of the polynomial in the form $ax^3 + bx^2 + cx + d$.

$$\frac{7}{4}, \frac{-7}{5}, \text{ and } \frac{5}{2}$$

The solution is $40x^3 - 114x^2 - 63x + 245$, which is option C.

A. $a \in [39, 49], b \in [114, 119], c \in [-65, -62],$ and $d \in [-247, -238]$

$40x^3 + 114x^2 - 63x - 245$, which corresponds to multiplying out $(4x + 7)(5x - 7)(2x + 5)$.

B. $a \in [39, 49], b \in [-87, -83], c \in [-137, -129],$ and $d \in [241, 248]$

$40x^3 - 86x^2 - 133x + 245$, which corresponds to multiplying out $(4x + 7)(5x - 7)(2x - 5)$.

C. $a \in [39, 49], b \in [-115, -112], c \in [-65, -62],$ and $d \in [241, 248]$

* $40x^3 - 114x^2 - 63x + 245$, which is the correct option.

D. $a \in [39, 49], b \in [-115, -112], c \in [-65, -62],$ and $d \in [-247, -238]$

$40x^3 - 114x^2 - 63x - 245$, which corresponds to multiplying everything correctly except the constant term.

E. $a \in [39, 49], b \in [25, 29], c \in [-220, -214],$ and $d \in [-247, -238]$

$40x^3 + 26x^2 - 217x - 245$, which corresponds to multiplying out $(4x + 7)(5x + 7)(2x - 5)$.

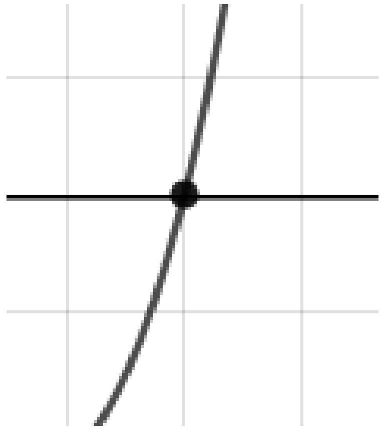
General Comment: To construct the lowest-degree polynomial, you want to multiply out $(4x - 7)(5x + 7)(2x - 5)$

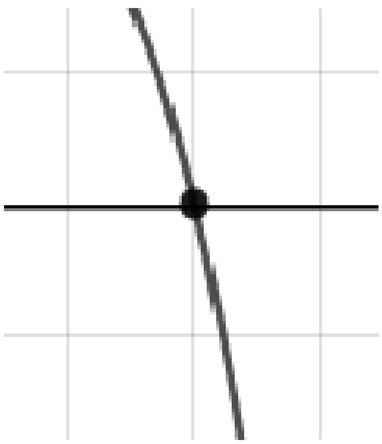
---

22. Describe the zero behavior of the zero $x = -8$ of the polynomial below.

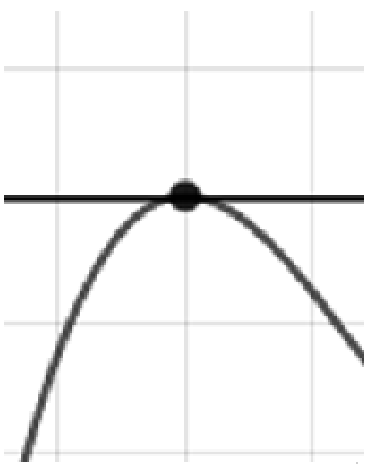
$$f(x) = 3(x + 7)^{11}(x - 7)^9(x - 8)^8(x + 8)^5$$

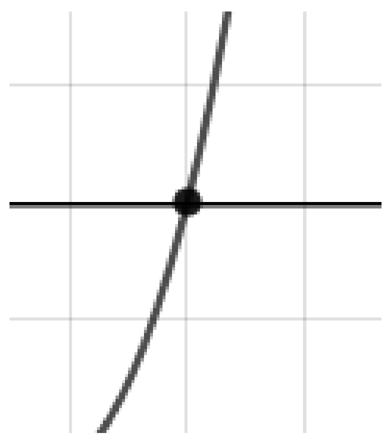
The solution is the graph below, which is option D.



A. 

C. 

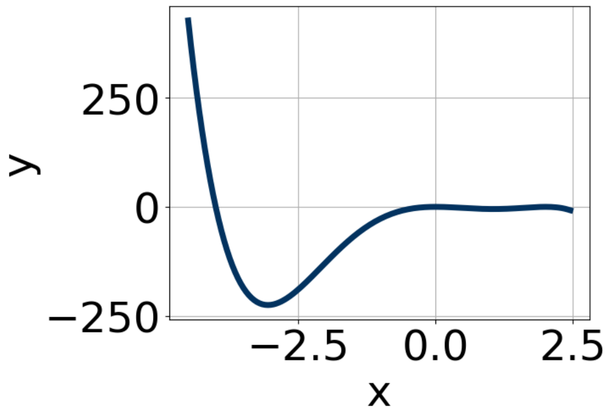
B. 

D. 

E. None of the above.

General Comment: You will need to sketch the entire graph, then zoom in on the zero the question asks about.

23. Which of the following equations *could* be of the graph presented below?



The solution is $-20x^4(x-2)^8(x+4)^{11}$, which is option A.

A. $-20x^4(x-2)^8(x+4)^{11}$

   * This is the correct option.

B. $-4x^8(x-2)^{11}(x+4)^7$

   The factor $(x-2)$ should have an even power.

C. $6x^4(x-2)^6(x+4)^8$

   The factor $(x+4)$ should have an odd power and the leading coefficient should be the opposite sign.

D. $-7x^8(x-2)^5(x+4)^8$

   The factor $(x-2)$ should have an even power and the factor $(x+4)$ should have an odd power.

E. $14x^6(x-2)^{10}(x+4)^7$

   This corresponds to the leading coefficient being the opposite value than it should be.

General Comment: General Comments: Draw the x-axis to determine which zeros are touching (and so have even multiplicity) or cross (and have odd multiplicity).

---

24. Construct the lowest-degree polynomial given the zeros below. Then, choose the intervals that contain the coefficients of the polynomial in the form $x^3 + bx^2 + cx + d$.

$$-5 - 3i \text{ and } -2$$

The solution is $x^3 + 12x^2 + 54x + 68$, which is option D.

A. $b \in [-1, 10], c \in [6.99, 8.99], \text{ and } d \in [7, 12]$

   $x^3 + x^2 + 7x + 10$, which corresponds to multiplying out $(x+5)(x+2)$.

B. $b \in [-16, -10], c \in [53.47, 55.02], \text{ and } d \in [-72, -63]$

   $x^3 - 12x^2 + 54x - 68$, which corresponds to multiplying out $(x-(-5-3i))(x-(-5+3i))(x-2)$.

C. $b \in [-1, 10], c \in [4.6, 5.04], \text{ and } d \in [1, 7]$

   $x^3 + x^2 + 5x + 6$, which corresponds to multiplying out $(x+3)(x+2)$.

D. $b \in [11, 13], c \in [53.47, 55.02], \text{ and } d \in [68, 69]$

   * $x^3 + 12x^2 + 54x + 68$, which is the correct option.

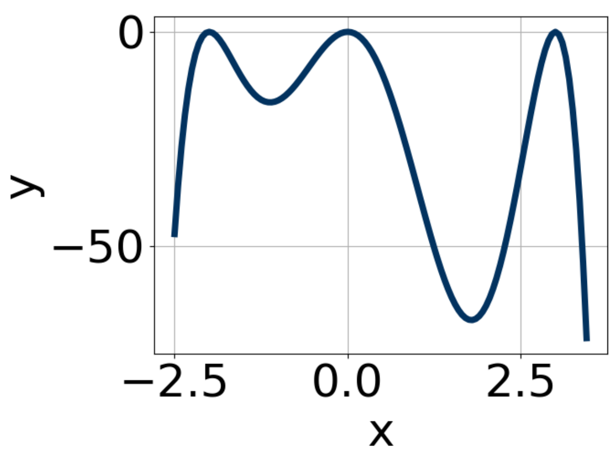
E. None of the above.

This corresponds to making an unanticipated error or not understanding how to use nonreal complex numbers to create the lowest-degree polynomial. If you chose this and are not sure what you did wrong, please contact the coordinator for help.

General Comment: Remember that the conjugate of $a + bi$ is $a - bi$. Since these zeros always come in pairs, we need to multiply out $(x - (-5 - 3i))(x - (-5 + 3i))(x - (-2))$.

---

25. Which of the following equations *could* be of the graph presented below?



The solution is $-17x^4(x-3)^{10}(x+2)^4$, which is option C.

A. $-13x^{10}(x-3)^4(x+2)^{11}$

The factor $(x + 2)$ should have an even power.

B. $11x^4(x-3)^4(x+2)^4$

This corresponds to the leading coefficient being the opposite value than it should be.

C. $-17x^4(x-3)^{10}(x+2)^4$

* This is the correct option.

D. $-8x^8(x-3)^7(x+2)^7$

The factors $(x - 3)$ and $(x + 2)$ should both have even powers.

E. $12x^{10}(x-3)^{10}(x+2)^{11}$

The factor $(x + 2)$ should have an even power and the leading coefficient should be the opposite sign.

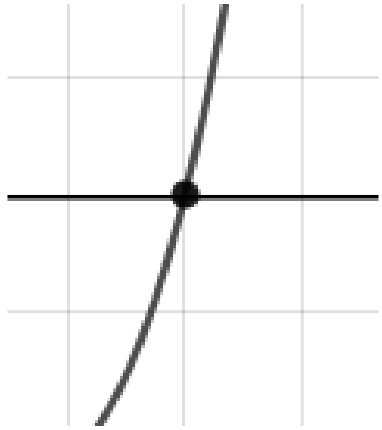
General Comment: General Comments: Draw the x-axis to determine which zeros are touching (and so have even multiplicity) or cross (and have odd multiplicity).

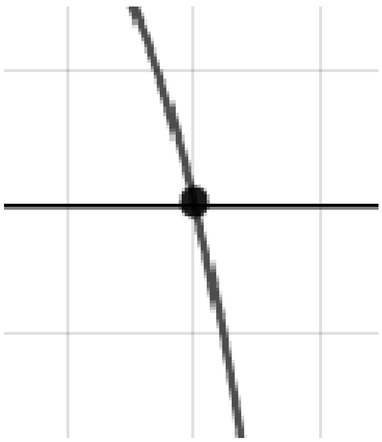
---

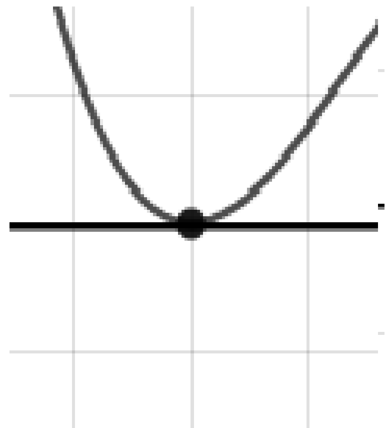
26. Describe the zero behavior of the zero $x = 3$ of the polynomial below.

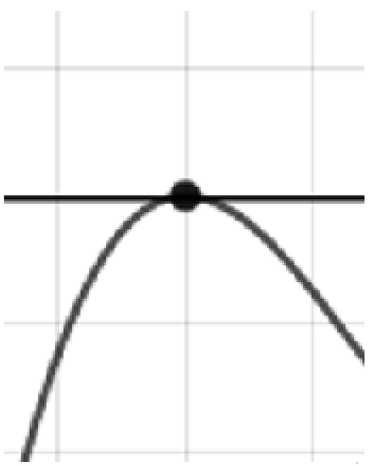
$$f(x) = 5(x-3)^5(x+3)^{10}(x+9)^6(x-9)^{10}$$

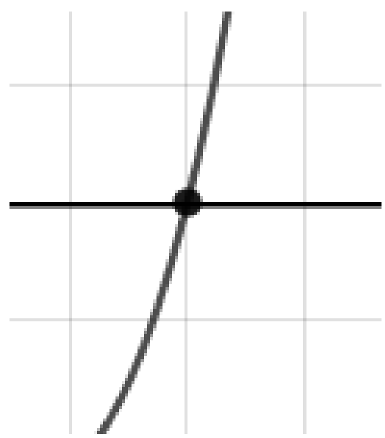
The solution is the graph below, which is option D.



A. 

C. 

B. 

D. 

E. None of the above.

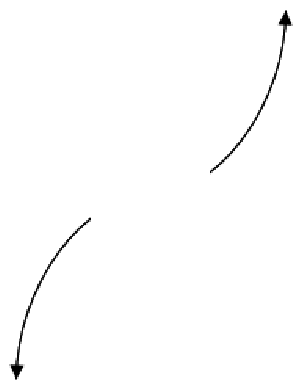
General Comment: You will need to sketch the entire graph, then zoom in on the zero the question asks about.

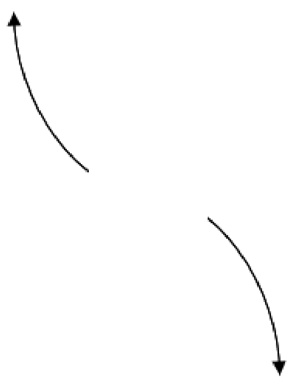
---

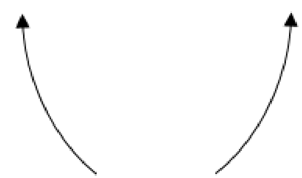
27. Describe the end behavior of the polynomial below.

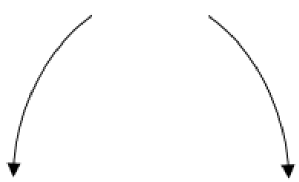
$$f(x) = 2(x+7)^3(x-7)^8(x-2)^2(x+2)^4$$

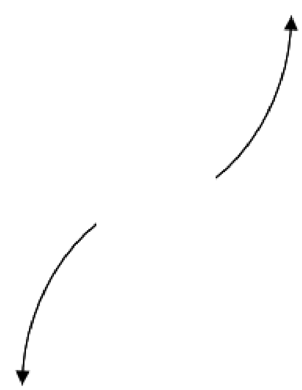
The solution is the graph below, which is option D.



A. 

C. 

B. 

D. 

E. None of the above.

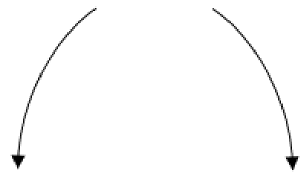
General Comment: Remember that end behavior is determined by the leading coefficient AND whether the **sum** of the multiplicities is positive or negative.

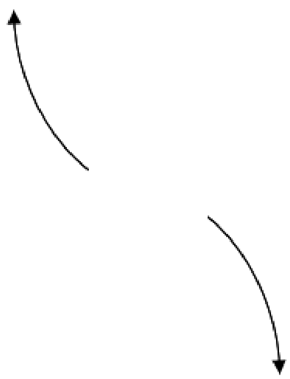
---

28. Describe the end behavior of the polynomial below.

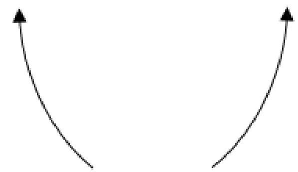
$$f(x) = -8(x-9)^4(x+9)^5(x+2)^4(x-2)^5$$

The solution is the graph below, which is option B.

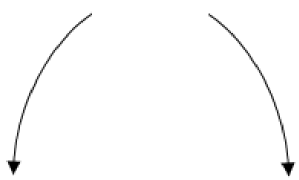




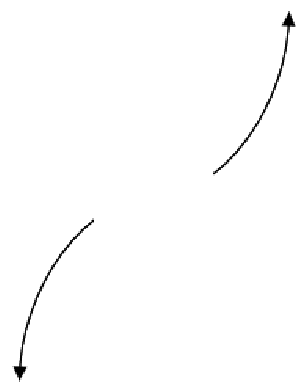
A.



C.



B.



D.

E. None of the above.

General Comment: Remember that end behavior is determined by the leading coefficient AND whether the **sum** of the multiplicities is positive or negative.

---

29. Construct the lowest-degree polynomial given the zeros below. Then, choose the intervals that contain the coefficients of the polynomial in the form $ax^3 + bx^2 + cx + d$.

$$\frac{-1}{4}, \frac{-1}{5}, \text{ and } \frac{4}{5}$$

The solution is $100x^3 - 35x^2 - 31x - 4$, which is option D.

A. $a \in [97, 105], b \in [-39, -33], c \in [-38, -27], \text{ and } d \in [2, 6]$

$100x^3 - 35x^2 - 31x + 4$, which corresponds to multiplying everything correctly except the constant term.

B. $a \in [97, 105], b \in [-125, -121], c \in [36, 47], \text{ and } d \in [-7, -2]$

$100x^3 - 125x^2 + 41x - 4$, which corresponds to multiplying out $(4x - 1)(5x - 1)(5x - 4)$.

C. $a \in [97, 105], b \in [-87, -79], c \in [-1, 8], \text{ and } d \in [2, 6]$

$100x^3 - 85x^2 - x + 4$, which corresponds to multiplying out $(4x - 1)(5x + 1)(5x - 4)$.

D. $a \in [97, 105], b \in [-39, -33], c \in [-38, -27],$ and $d \in [-7, -2]$

* $100x^3 - 35x^2 - 31x - 4$, which is the correct option.

E. $a \in [97, 105], b \in [32, 40], c \in [-38, -27],$ and $d \in [2, 6]$

$100x^3 + 35x^2 - 31x + 4$, which corresponds to multiplying out $(4x - 1)(5x - 1)(5x + 4)$.

General Comment: To construct the lowest-degree polynomial, you want to multiply out $(4x + 1)(5x + 1)(5x - 4)$

---

30. Construct the lowest-degree polynomial given the zeros below. Then, choose the intervals that contain the coefficients of the polynomial in the form $x^3 + bx^2 + cx + d$.

$$3 - 3i \text{ and } 4$$

The solution is $x^3 - 10x^2 + 42x - 72$, which is option D.

A. $b \in [-1, 7], c \in [-6, 0],$ and $d \in [-14, -11]$

$x^3 + x^2 - x - 12$, which corresponds to multiplying out $(x + 3)(x - 4)$.

B. $b \in [-1, 7], c \in [-8, -2],$ and $d \in [10, 13]$

$x^3 + x^2 - 7x + 12$, which corresponds to multiplying out $(x - 3)(x - 4)$.

C. $b \in [5, 20], c \in [34, 44],$ and $d \in [72, 78]$

$x^3 + 10x^2 + 42x + 72$, which corresponds to multiplying out $(x - (3 - 3i))(x - (3 + 3i))(x + 4)$.

D. $b \in [-10, -5], c \in [34, 44],$ and $d \in [-77, -69]$

* $x^3 - 10x^2 + 42x - 72$, which is the correct option.

E. None of the above.

This corresponds to making an unanticipated error or not understanding how to use nonreal complex numbers to create the lowest-degree polynomial. If you chose this and are not sure what you did wrong, please contact the coordinator for help.

General Comment: Remember that the conjugate of $a + bi$ is $a - bi$. Since these zeros always come in pairs, we need to multiply out $(x - (3 - 3i))(x - (3 + 3i))(x - (4))$.
